High-Performance, Oxide-Dispersion-Strengthened Tubes for Production of Ethylene and Other Industrial Chemicals

Benefits

This project can have substantial benefits in a number of the IOF industries.

- For the ethylene industry, the greatest energy and economic benefits will accrue through higher ethylene yields and/or reduced tubing replacements.
- For the other chemical industries, the greatest energy and economic benefits are likely to accrue through reduced tubing replacement costs and/or improvements in reactor productivity.
- The greatest energy savings will be achieved through more efficient process operations, higher process yields, and less frequent replacement of alloy tubing.

Applications

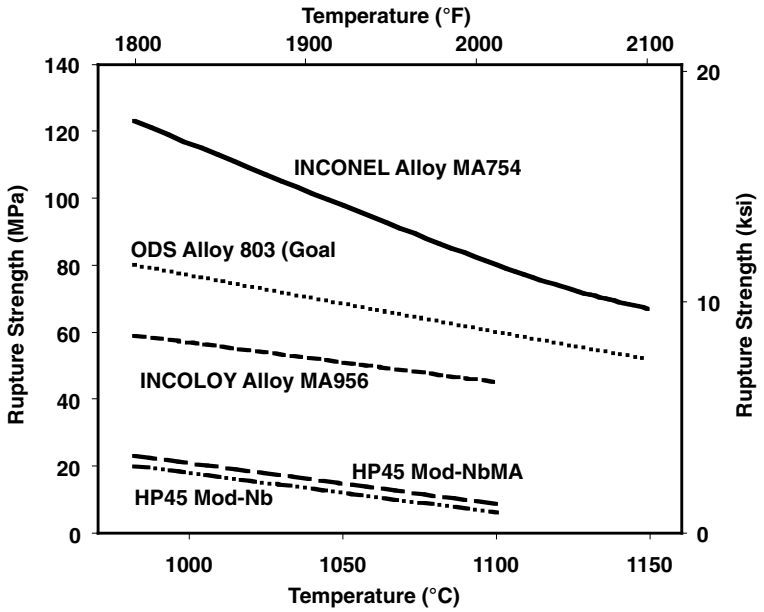
The results of the project will be applicable to various industries; however, the focus is on development of a higher-temperature-capable coextruded oxide-dispersion-strengthened tube for use in ethylene production. The tubes would have higher-temperature creep strength properties over currently used alloys. Typical industries and anticipated applications include

- **Chemical:** Ethylene, ammonia, methanol, and hydrogen production;
- **Heat Treating:** Higher-temperature-capable materials of construction;
- **Petrochemical:** Tubes with higher-temperature capability, steam reforming;
- **Agriculture;** and
- **Petroleum**.

Oxide-dispersion-strengthened tubes will enable higher operating temperatures, leading to more efficient ethylene production

This project seeks to develop higher-temperature, coking-resistant, fabricable tubes for ethylene pyrolysis and steam methane reforming. Oxide-dispersion-strengthened (ODS) tubes are expected to have high creep resistance, exhibit substantial fabricability, and show environmental benefits. These novel tubes are expected to allow an increase of 65°C in tube operating temperature during ethylene production and a doubling of time between decoking cycles at equivalent temperature.

The specific objective is to develop a clad INCOLOY™ Alloy MA 956/ODS Alloy 803 tubing that exhibits up to a factor of 2 improvement in creep strength and coking resistance compared with current alloys. The work will have substantial benefits for a number of IOF industries but is primarily focused on ethylene production.



10,000-hour creep rupture strengths of several candidate alloys.

Project Description

Goal: The goal of this project is to develop a high-temperature creep-resistant and coking-resistant clad ODS tubing for use in industrial-scale ethylene production and steam methane reforming operations. The specific objective is to develop a clad INCOLOY™ Alloy MA 956/ODS Alloy 803 tubing that exhibits up to a factor of 2 improvement in creep strength and coking resistance compared with current alloys.

Issues: The industry continues to look for improved materials and other technologies to enable more efficient ethylene operations under increasingly severe pyrolysis/cracking conditions (higher temperatures, shorter residence times, and lower partial pressures of product), leading to increased ethylene yields. Current alloys have specific issues that limit operations related to their performance at increasingly high design process temperatures. This is the case currently for both castable alloy tubes and wrought tubes.

The principal hurdles of this project will be to (1) demonstrate successful alloy development and powder production of the ODS Alloy 803 with increased creep strength, lower catalytic coking than current materials, and field fabricability; (2) demonstrate successful coextrusion cladding of the ODS Alloy 803, including good bonding at the interface between the two alloys; and (3) demonstrate the field viability of this type of clad tubing.

Approach: The tasks for the project include
- Development of the ODS alloy;
- Development of coextruded alloy tubes;
- Characterization of the alloys and coextruded tubes;
- Engineering laboratory-scale testing and evaluation of tubes (evaluation of coking resistance, oxidation resistance, carburization resistance, weldability, and field fabricability); and
- Testing of tubes in a commercial environment.

Potential payoff: The project results can provide a number of direct benefits to chemical and petrochemical firms involved with the production of ethylene, ammonia, methanol, and hydrogen. For the ethylene industry, the greatest benefits will accrue through higher ethylene yields and/or lower tubing replacement costs.
- The clad ODS Alloy 803 tubing to be produced under the project may enable a 35% increase in ethylene yields for a given furnace.
- If the clad tube enables an extension of the intervals between decoking cycles and and extension of tube life, it may be possible to decrease both lost production time due to decoking and tube replacement costs by a factor of two.
- By reducing coke buildup, the clad tubing will enable more thermally efficient processing. In addition, the higher-strength ODS material will enable tube wall thicknesses to be decreased, further raising the thermal efficiency of ethylene furnaces.

For other industries, the greatest benefits will accrue through reduced tube replacement and/or improvements in chemical reactor productivity.

Progress and Milestones

- ODS Alloy 803 Development: develop ODS Alloy 803 exhibiting creep strength comparable to INCOLOY™ Alloy MA 956.
- Coextrusion Process Development: demonstrate production of coextruded INCOLOY™ Alloy MA956/ODS Alloy 803 tube exhibiting uniform cladding thickness and good bonding between the ferritic and austenitic material.
- Industrial-Scale Evaluation: determine that coextruded tubing is sufficiently robust to function as ethylene-pyrolysis or steam methane reformer tubing.

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